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Evaluating Scientific Theories

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One would have thought that doubts about the testability of evolutionary theory (and, by association, evolutionary psychology) would have been laid to rest a long time ago, most decisively by Darwin himself. Yet, such doubts seem to have remarkable staying power. I can testify (as doubtless can others) that in conversations with fellow academics one of the most common criticisms launched at evolutionary psychology is its lack of testability. Moreover, it typically becomes clear in the subsequent (sometimes heated) debate that lying behind such a criticism is a particular conception of what "science" amounts to, which is all too often either naively empiricist or Popperian in nature.

Hence, I welcome the target article by Ketelaar and Ellis (this issue), which presents a splendidly argued and cogent analysis. First, they unpack the different senses in which it might be claimed that evolutionary psychology might be untestable. Second, they present a conception of scientific progress by Lakatos that represents a considerable updating and improvement over Popper's falsificationist framework. Applying both strategies they convincingly show that, no matter how the notion of testability is unpacked, the program of evolutionary psychology is both testable and represents a paradigmatic case of science in action. In short, this article will almost certainly add to my own argumentative armamentarium when indulging in vigorous debates over evolutionary psychology.

Any concerns I do have about Ketelaar and Ellis's arguments revolve around their use of a Lakatosian framework, which they describe variously as representing contemporary philosophy or as embodying principles drawn from modern-day philosophy of science. Well, Lakatos is not the only contemporary game in town; indeed, my sense is that Lakatosian models have been superceded in philosophy of science circles, to some extent, by models that both adopt a realist perspective and exploit the notion that there exist a wide range of criteria by which theories are evaluated (see, e.g., Fletcher, 1996; Laudan, 1996; McMullin, 1984). I make clear from the outset that my aim is to reinforce the general argument offered by Ketelaar and Ellis. That is, I wish to show that even if a Lakatosian framework is replaced by an alternative and popular contemporary approach, the conclusion remains fast that evolutionary psychology is eminently testable from top to bottom.

Models of scientific inference or methodology embody a rather curious dual role. On the one hand, they offer normative frameworks that essentially give advice as to how science (or theory evaluation) should proceed in a rational fashion. On the other hand, they offer descriptive accounts that should, at least roughly, fit how science actually does proceed. Theoretically, of course, one could offer a normative framework that specifies how science should proceed in an ideal world that is miles away from what actually happens in the real scientific world. However, such a large gap would immediately raise severe suspicions and invite close scrutiny about the status of the normative standards. Indeed, I suspect this is the basic reason that led to Popper's falsificationist approach being more or less abandoned.

The major weakness of a Lakatosian approach, in my view, is that it remains a little too close for comfort to Popper's model of scientific inference. More specifically, it remains too wedded to the role and centrality of prediction as the major tool of theory evaluation. Thus, metatheories that generate novel predictions and explanations, and have the resources to deal with and solve apparent anomalies, are regarded as progressive. In contrast, those theories that fail to generate novel predictions and explanations, and have difficulty with dealing with anomalies, are regarded as degenerative.

Judging Darwinian evolutionary theory from a contemporary perspective, it is obvious that it represents a progressive theory in Lakatosian parlance. However, this theory has been around for an awfully long time (140 years) and it is by no means clear that judgments of the theory made in previous times would have revealed such a rosy view. Indeed, commentators have often remarked on the extent to which Darwinian evolutionary theory essentially remained static for enormously long periods of time, replete with yawning gaps and unexplained anomalies (e.g., Dennett, 1995). To give three examples: It took until 1906 for the problem of the age of the earth to be solved (Burchfield, 1975); it took until the 1940s for the synthesis between the work on genes and natural selection to be made reasonably secure (Dennett, 1995); and it took until the 1960s for the problem of altruism to be solved (as described in the target article). I suspect that Darwin's theory might well have failed the Lakatosian test if judged, say, 50 years after it was initially postulated, which raises the question as to why Darwinian theory was so successful and convincing from the outset (almost 50% of scientists from 1859 to 1869 were converted to evolutionary theory within 1 year of reading *The Origin of Species* [Darwin, 1859]; Hull, 1988).

The enduring persuasiveness of Darwin's famous original evolutionary treatise can be tied to two factors. Darwin was certainly not the first to promote the view that life on earth has evolved, but he presented a meticulously detailed and organized array of evidence that essentially rendered the fact of evolution inescapable. Darwin's masterstroke, however, was to also hypothesize mechanisms that could plausibly account for the fact of evolution. Perhaps one reason why Darwinian evolutionary theory has since proved to be so successful (despite its lack of progressivity for long periods of time) is the profound difficulty in producing plausible alternatives. Moreover, analyzing the way in which some of the major anomalies that have afflicted evolutionary theory have been solved is illuminating. The case described by Ketelaar and Ellis concerned with altruism certainly fits into a Lakatosian framework, in that the problem was essentially solved via elaborations of evolutionary theory itself.

However, the other two anomalies with evolutionary theory I cited previously were not solved in a way that neatly fit into a Lakatosian view. Calculations made by Lord Kelvin (based on the laws of thermodynamics) initially in 1862, and refined over the next 35 years, showed that the earth was less than 40 million years old—a figure that seemed to decisively disprove Darwin's theory of evolution, as this meant there was simply not enough time for evolution to have occurred (see Burchfield, 1975). Perhaps the most telling of Kelvin's calculations was the amount of time it would have taken for the earth to have cooled down from a molten state to its present state. The decisive blow to Kelvin's estimates did not come until 1906 when Rutherford realized that the discovery of radiation (an internal source of heat in the earth) enormously increased the estimated probable age of the earth. In the case of identifying the genetic mechanisms at work that underpin evolution, the initial breakthrough was forged by Mendel and published in 1865. It took another 35 years before its relevance to evolutionary theory was even dimly realized. In both cases, then, major anomalies and gaps in evolutionary theory were solved in a serendipitous fashion by scientists who were working on theories and research programs that were not remotely concerned with evolutionary theory.

The general point such examples illustrate (and they could be multiplied endlessly for successful scientific theories) is that a potent criterion for evaluating scientific theories is in terms of their ability to mesh with other well-accepted theories or entrenched knowledge. As Dennett (1995) put it:

> Like Gulliver tied down to Lilliput, it (evolutionary theory) is unbudgable, ... because it is securely tied by hundreds of thousands of threads of evidence anchoring it to virtually every other area of knowledge. ... the hope that it will be "refuted" by some shattering breakthrough is about as reasonable as the hope that we will return to a geocentric vision and discard Copernicus. (p. 20)

Unfortunately, the need for a theory to mesh with, and be consistent with, well-accepted theories or entrenched bodies of knowledge in other domains is missing from a Lakatosian approach. Moreover, this particular criterion for evaluating theories is not the only one missing from a Lakatosian approach. For example, scientists also assess theories according to their elegant simplicity, their internal coherence, and their ability to explain the underlying causal machinery at work. If the values of predictive accuracy, fertility, and replication of results are added, a rather long list of criteria is produced that scientists use in evaluating and comparing scientific theories. This kind of multicriterial approach has several points in its favor.

First, it fits rather well with the way in which scientists actually do evaluate theories.

Second, it helps solve the problem as to why scientists conservatively held onto their theories in the face of failed predictions, and it accounts for why such conservatism is perfectly rational; namely, predictive accuracy becomes only one criterion among several to take into account when evaluating and comparing theories. I am perfectly happy to concede that predictive accuracy is a critically important criterion. It may even be the single most important criterion. But it is not the only criterion.

Third, such a model provides a straightforward rationale for why theories become steadily more difficult to refute as they become more general and less focused;

namely, they will tend to become more steadily enmeshed in other areas of knowledge and entrenched theories (which are likely to come from psychology, physics, biology, geology, folk psychology, and so forth). The consequences of overthrowing theories as one approaches the core of our theoretical and knowledge domains, thus, inevitably become more radical and difficult to countenance. A Lakatosian approach advances the concept of a protective belt thrown around the hard theoretical core, which Lakatos proposes offers a "strategic retreat" when dealing with disconfirmatory findings. I am not entirely comfortable with such a Lakatosian approach. I believe that scientists always need to keep a weather eye open for the implications that evidence collected at lower theoretical levels has for theories operating further up the theoretical chain, right up to and including the core theory itself. Indeed, it is arguably the case that evolutionary theory would not have been as progressive as it has been, unless at least some scientists had ignored the protective belt (insofar as it exists) and reexamined Darwinian evolutionary theory in light of lower order evidence.

Fourth, a multicriterial model also (partly) explains why it is that scientists often argue over which theories are more successful; namely, that scientists can and do disagree about the relative importance given to particular criteria. An example is the current debate in cognitive science raging around the merits of a connectionist approach to cognition, as an alternative to the more traditional computational models. Critics stress the point that connectionist models fall down on predictive accuracy; for example, that they are too powerful, modeling what humans can do as well as what are clearly beyond human capabilities (e.g., Massaro & Cowan, 1993; McCloskey, 1991). Its supporters, in turn, downplay its predictive failures and argue that connectionism is superior in terms of unifying power, parsimony, and fertility (see, e.g., Seidenberg, 1993).

The notion that testability is one of the key characteristics of scientific theories is a virtually unchallenged belief in mainstream science, and for good reason. However, provided that this axiom is placed within a perspective that recognizes the complexity and subtlety of the links between evidence and theory evaluation (and I include a Lakatosian framework here) then it is abundantly clear that evolutionary theory and evolutionary psychology pass the testability hurdle with flying colors. The notion that everything is potentially revisable is a central assumption of the scientific approach. However, as the target article by Ketelaar and Ellis makes cogently clear, not all theories (or components of theories) are, in practice, equally revisable.

Note

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Prediction and Accommodation in Evolutionary Psychology

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Ketelaar and Ellis (this issue) have provided a remarkably clear and succinct statement of Lakatosian philosophy of science and have also argued compellingly that the neo-Darwinian theory of evolution fills the Lakatosian criteria of progressivity. We find ourselves in agreement with much of what Ketelaar and